

Annual Reports :: Year 6 :: Pennsylvania State University

Project Report: Prebiotic Synthesis: Experimental Studies

Project Investigator:

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Project Progress

Research in this reporting period concentrated on two topics: fate of formate and the interaction of RNA with pyrite. Graduate student Alex Smirnov built an experimental setup to measure the decomposition of formate over a temperature range from 35 to 150°C. To avoid degassing, the experiments were conducted without the presence of a head space. The rates obtained by Alex are, however, several orders of magnitude higher than those obtained by extrapolating existing hydrothermal data down to the temperature range of interest. This discrepancy either means that there is still an artifact in our setup that leads to an acceleration of the decomposition or there is a fundamental change in the reaction mechanism at low temperature. In the fall of 2004, Alex Smirnov will work with Tom McCollom, University of Colorado and NAI, to resolve this issue.

Our work on the interaction between RNA and pyrite started with our discovery that pyrite, when contacted with water, produces hydrogen peroxide and OH radicals. The formation of OH radicals could have limited the stability of RNA and/or have accelerated molecular evolution through mutagenesis. Using batch experiments we have shown that RNA is rapidly decomposed, i.e., the strands are broken into smaller fragments as demonstrated with gel electrophoresis. The gel electrophoresis work was conducted in collaboration with post doc Steffen Mueller, Department of Microbiology at Stony Brook. Recombination of these fragments could have led to an acceleration of the molecular evolution. We have also shown that NiS₂ is reactive in this respect and we are now exploring other common minerals. We are currently using advanced spectroscopic techniques to understand the fundamental reactions that lead to the formation of the radicals.

Highlights

- Pyrite leads to the decomposition of RNA, which could have limited the stability of RNA on early Earth or may have accelerated molecular evolution by recombination of RNA fragments.

Roadmap Objectives

- **Objective No. 3.1: Sources of prebiotic materials and catalysts**

Cross Team Collaborations

Graduate student Alex Smirnov consulted with Tom McCollom at Colorado University. This led to the submission of a student supplement for him to conduct experiments at Colorado University this upcoming Fall.